Free gingival grafts to increase keratinized tissue: a retrospective long-term evaluation (10 to 25 years) of outcomes

Free Gingival Grafts to Increase Keratinized Tissue: A Retrospective Long-Term Evaluation (10 to 25 years) of Outcomes

Giancarlo Agudio,* Michele Nieri,† Roberto Rotundo,† Pierpaolo Cortellini,‡ and Giovanpaolo Pini Prato†

Background: Gingival augmentation procedures are indicated primarily to increase an insufficient amount of gingiva and sometimes to halt the progression of gingival recession. The aim of this retrospective long-term study was to evaluate changes in the amount of keratinized tissue (KT) and in the position of the gingival margin after free gingival graft procedures over a period of 10 to 25 years.

Methods: One hundred three subjects presenting with 224 sites completely lacking attached gingiva associated with gingival recessions were treated in a private practice. The experimental sites were treated with gingival augmentation procedures (free gingival grafts). The grafts were positioned at the presurgical level of the gingival margin or in a submarginal position. Clinical variables, including recession depth, amount of KT, and probing depth (PD), were measured at baseline (T_0), 1 year after surgery (T_1), and at the end of the follow-up period (10 to 25 years) (T_2) and analyzed using descriptive statistics and multilevel models.

Results: From T_0 to T_1, the gingival margin shifted coronally 0.8 mm, and KT increased 4.2 mm. From T_1 to T_2, the gingival margin shifted coronally 0.6 mm, and the overall KT decreased 0.7 mm. PD remained stable.

Conclusion: Gingival augmentation procedures performed in sites with an absence of attached gingiva associated with recessions provide an increased amount of KT associated with recession reduction over a long period of time. *J Periodontol 2008;79:587-594.*

KEY WORDS

Follow-up; gingiva; gingival recession; grafts.

* Private practice, Bergamo, Italy.
† Department of Periodontology, University of Florence, Florence, Italy.
‡ "Accademia Toscana di Odontostomatologia," Florence, Italy.

For many years, the presence of an "adequate" amount of gingiva was considered a keystone for the maintenance of periodontal health.[1-4] In an observational study, Lang and Löe[5] reported that despite the fact that the tooth surfaces were free from plaque, "all surfaces with less than 2.0 mm of keratinized gingiva exhibited clinical inflammation and varying amounts of gingival exudates." Other investigators[6-8] failed to find a similar association and reported that it is possible to maintain healthy marginal tissues, even in areas with a reduced or missing keratinized gingiva.

However, the presence of site-related conditions, e.g., gingival recession, thin periodontium, and root prominence, combined with a reduced or missing amount of attached gingiva, may indicate a gingival augmentation procedure.[9,10] In particular, Serino et al.[9] showed that sites with gingival recession should be considered susceptible to additional apical displacement of the soft tissue margin. Based on existing evidence, the American Academy of Periodontology suggested several indications for gingival augmentation procedures: to prevent soft tissue damage in the presence of alveolar bone dehiscence during natural or orthodontic tooth eruption; to halt progressive marginal gingival recession; to improve plaque control and patient comfort around teeth

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and implants; and to increase the insufficient dimension of gingiva in conjunction with fixed or removable prosthetic dentistry.[10]

A free gingival graft procedure is one of the most common approaches for gingival augmentation.[11-15] Some studies reported short- or medium-term data dealing with the stability of the gingival margin after free gingival graft procedures. Dorfman et al.,[16] in a split-mouth study, treated 22 subjects with a free gingival graft procedure. The 4-year comparison between control untreated sites and test sites revealed significant differences in the amount of keratinized tissue (KT), attached gingiva, and recession; no other differences were observed. The same results were reported by Kennedy et al.[17] in a subgroup analysis of 14 subjects after 6 years and in another study by Hangorsky and Bissada.[18]

Very limited data on the position of the gingival margin after the application of a free gingival graft over a long period of time are available.[19]

The aim of this retrospective long-term study was to evaluate the changes in the amount of KT and in the position of the gingival margin in sites treated with two different free gingival graft procedures (marginal free gingival graft [MFGG] and submarginal free gingival graft [SMFGG]) over a period of 10 to 25 years.

MATERIALS AND METHODS

Study Population

Subjects referred to a private practice in Bergamo, Italy between 1981 and 1996 with the following entry criteria were selected for this study: full-mouth plaque/bleeding score <20%, presence of at least one site with complete absence of attached gingiva associated with gingival recession, and normal sulcus depth. All subjects signed a consent form for the surgical treatment and agreed to allow the use of their clinical data for this retrospective clinical trial, in accordance with the Helsinki Declaration of 1975, as revised in 2000. One expert periodontist (GA) performed the clinical measurements and surgery.

Measurements

The following subject-, tooth-, and site-associated variables were recorded for each subject at baseline (T_0), 1 year after surgery (T_1), and at the end of the follow-up period (from 10 to 25 years) (T_2).

Subject-associated variables included age, gender, and tobacco smoking. Tooth-associated variables included position (maxillary or mandibular), type of tooth, tooth mobility, presence of restorations, presence of splints, tooth vitality, and presence of tooth malposition. Site-associated variables included: gingival recession depth (Rec, at the mid-buccal point, the distance between the gingival margin and the cemento-enamel junction [CEJ]; in the presence of restorations, the most apical margin of restoration was used as the reference point); KT width (at the mid-buccal point, from the gingival margin to the mucogingival junction); presence of CEJ abrasion; interproximal bone loss (evaluated on periapical radiographs, yes or no); plaque index (PI, at the experimental site[20]); bleeding on probing (BOP, at the experimental site[20]); and probing depth (PD, at the experimental site).

All periodontal measurements were taken using Williams offset periodontal probes. The probes used for the clinical measurements were selected from many with the aid of a caliper, to get probes with accurate and identical scales. This group of calibrated probes (n = 20) was used through the years for all clinical measurements.

Surgical Procedure

All subjects enrolled in the study underwent gingival augmentation procedures (free gingival grafts) to treat the absence of attached gingiva.

Before surgery, all subjects were instructed and motivated to use proper oral hygiene procedures (atraumatic, apico-coronal brushing technique and personalized interproximal cleaning methods).

Free gingival grafts were performed according to the original technique described by Sullivan and Atkins.[13] In brief, a recipient bed was prepared on the experimental site, and a free graft was harvested from the palate. In cases in which the free gingiva was judged as very thin, the coronal part of the graft was positioned approximately at the presurgical level of the gingival margin after the removal of the existing thin free gingiva (MFGG). When the free gingiva was judged as thick, the graft was sutured at a submarginal level, leaving the resident thicker free gingiva in its original position (SMFGG). Surgical dressing was used in all cases. Sutures were removed 10 days after surgery. The subjects were recalled every 4 months for supportive periodontal treatment.

Statistical Analyses

Descriptive statistical analyses were performed using mean ± SD for quantitative variables and frequency and percentage for qualitative variables.

Inferential statistics were applied using multilevel linear regression models at three levels: subject, tooth/site, and time (T_1 and T_2).§ The outcome variables were KT and recession. Explicative variables at the subject level were gender and smoking; at the tooth level, they were maxillary versus mandibular tooth, premolar/molar versus incisor/canine tooth, presence of interproximal bone loss, age at surgery, recession at T_0, restorations, and splints; at the time level, they were T_1 versus T_2.

§ MLwiN 1.0, Multilevel Models Project, Institute of Education, Bristol, U.K.

RESULTS

A total of 105 subjects (24 males and 81 females, aged 18 to 58 years; 19 smokers and 86 non-smokers) provided 247 sites for gingival augmentation procedures.

Of 247 treated teeth, 23 teeth in 13 subjects were excluded from the analysis: two teeth were lost to fracture and 21 teeth because of the loss of the baseline reference point (CEJ) due to preparation for prosthetic crowns/cervical restorations.

Therefore, 224 teeth (103 subjects) were used for statistical analyses. Seventy-six (34%) sites were treated with MFGG, and 148 (66%) sites were treated with SMFGG.

One case treated with MFGG is shown in Figures 1 through 4, whereas one case treated with SMFGG is shown in Figures 5 through 8.

Descriptive Statistics

Descriptive statistics at baseline, 1 year, and the follow-up examination are reported in Tables 1, 2, and 3, respectively.

At baseline (T_0) at the site level, no significant differences were observed in terms of PD, KT, PI, or BOP between MFGG and SMFGG. Only a slight difference in mean initial recession was detected between MFGG (3.2 ± 1.2 mm) and SMFGG (2.2 ± 1.1 mm; $P<0.0001$) (Table 1).

At 1 year after surgery (T_1), overall in the experimental sites the recession associated with the lack of KT was reduced ($Rec_{T0\text{-}T1}$ = 0.8 ± 0.6 mm), the mean amount of KT was increased ($KT_{T1\text{-}T0}$ = 4.2 ± 1.2 mm), and the mean PD remained stable ($PD_{T0\text{-}T1}$ = 0.0 ± 0.2 mm). In the MFGG group, the recession reduction ($Rec_{T0\text{-}T1}$) was 1.0 ± 0.7 mm, whereas it was 0.6 ± 0.6 mm in the SMFGG group. The mean increase in KT was 4.4 ± 1.4 and 4.1 ± 1.0 mm for the MFGG and SMFGG groups, respectively (Table 2).

Figure 1.
Mandibular canine: gingival recession associated with an absence of attached gingiva.

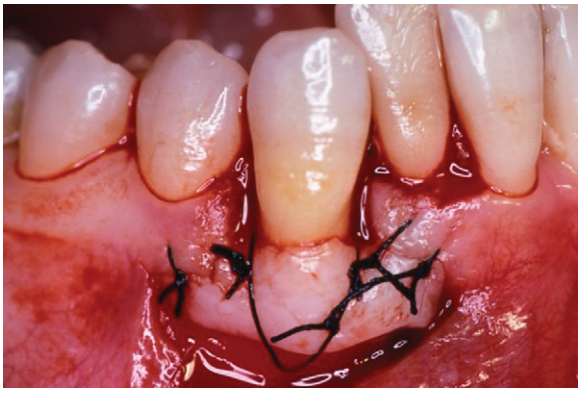

Figure 2.
MFGG aimed to increase the KT width (year 1983).

Figure 3.
One year after surgery (year 1984): the amount of KT is increased.

At the end of follow-up (T_2), an additional reduction in mean gingival recession was observed ($Rec_{T1\text{-}T2}$ = 0.6 ± 0.7 mm), the mean amount of KT was reduced slightly with respect to the 1-year measurement ($KT_{T2\text{-}T1}$ = –0.7 ± 0.8 mm), and mean PD remained stable ($PD_{T1\text{-}T2}$ = –0.0 ± 0.2 mm) (Table 3).

Figure 4.
End of follow-up 23 years later (year 2006): increased KT associated with physiologic sulcus depth. Notice the coronal shift of the gingival margin.

Figure 6.
MFGG aimed to increase the KT width (year 1985).

Figure 5.
Mandibular premolar: gingival recession associated with an absence of attached gingiva.

Figure 7.
One year after surgery (year 1986): the amount of KT is increased.

Figure 8.
End of follow-up 22 years later (year 2007): increased KT associated with physiologic sulcus depth. Notice the coronal shift of the gingival margin.

From baseline, the overall mean recession reduction (Rec_{T0-T2}) was 1.4 ± 0.9 mm, the mean amount of KT gain (KT_{T2-T0}) was 3.4 ± 1.0 mm, and the mean PD change (PD_{T0-T2}) was –0.0 ± 0.2 mm.

Considering the two groups, the mean recession reduction (Rec_{T0-T2}) was 1.8 ± 1.0 and 1.2 ± 0.8 mm for MFGG and SMFGG, respectively. Only two teeth showed a slight increase (1 mm) in gingival recession in the SMFGG group. The increased amount of KT (KT_{T2-T0}) was 3.5 ± 1.0 and 3.4 ± 0.9 mm for the MFGG and SMFGG groups, respectively.

Figures 9 and 10 show the healing patterns of MFGG and SMFGG.

Inferential Statistics

Multilevel analyses are reported in Tables 4 and 5.

The outcome variable "KT width" at 1 year and at the end of the follow-up examination was associated significantly with tooth type (molars and premolars showed a smaller amount of KT at T_1 and T_2 than anterior teeth, $P<0.0001$); the presence of splints was associated with an increased amount of KT ($P<0.0026$); KT_{T1} was slightly greater than KT_{T2} ($P<0.0001$); and no difference was observed between the two grafting procedures (Table 4).

The outcome variable "position of the gingival margin" (considered variable: recession) at 1 year and at the end of follow-up was associated significantly with age, type of surgical technique (SMFGG versus

Table 1.

Descriptive Statistics at Baseline (T_0)

	MFGG (N = 76)	SMFGG (N = 148)
Age at surgery (years; mean ± SD)	35.7 ± 10.1	36.9 ± 9.3
Mandibular teeth (n [%])	58 (76)	122 (82)
Maxillary teeth (n [%])	18 (24)	26 (18)
Incisors (n [%])	34 (45)	46 (31)
Canines (n [%])	15 (20)	33 (22)
Premolars (n [%])	24 (31)	67 (45)
Molars (n [%])	3 (4)	2 (1)
Buccal (n [%])	73 (96)	148 (100)
Lingual (n [%])	3 (4)	0 (0)
Cervical abrasions (n [%])	18 (24)	20 (14)
Restoration (n [%])	23 (30)	50 (34)
Malpositioned teeth (n [%])	76 (100)	136 (92)
Splint (n [%])	23 (30)	25 (17)
Tooth vitality (n [%])	68 (89)	138 (93)
PI (site) (n [%])	2 (3)	2 (1)
BOP (site) (n [%])	5 (7)	4 (3)
Recession (site) (mm; mean ± SD)	3.2 ± 1.2	2.2 ± 1.1
KT (site) (mm; mean ± SD)	1.0 ± 0.2	1.1 ± 0.3
PD (site) (mm; mean ± SD)	1.0 ± 0.2	1.0 ± 0.1

Table 2.

Descriptive Statistics at 1 Year After Surgery (T_1)

	MFGG	SMFGG
PI (site) (n [%])	0 (0)	0 (0)
BOP (site) (n [%])	0 (0)	0 (0)
Recession (site) (mm; mean ± SD)	2.1 ± 1.1	1.6 ± 1.1
KT (site) (mm; mean ± SD)	5.4 ± 1.4	5.2 ± 1.0
PD (site) (mm; mean ± SD)	1.0 ± 0.0	1.0 ± 0.1
Complete root coverage T_1 (n [%])	4 (5)	22 (15)
Rec reduction (T_0-T_1) (mm; mean ± SD)	1.0 ± 0.7	0.6 ± 0.6
KT gain (T_1-T_0) (mm; mean ± SD)	4.4 ± 1.4	4.1 ± 1.0

Table 3.

Descriptive Statistics at the End of Follow-Up (T_2)

	MFGG	SMFGG
Years of follow-up (n; mean ± SD)	17.2 ± 4.3	13.4 ± 2.8
PI (site) (n [%])	0 (0)	0 (0)
BOP (site) (n [%])	1 (1)	0 (0)
Recession (site) (mm; mean ± SD)	1.3 ± 1.1	1.0 ± 1.1
KT (site) (mm; mean ± SD)	4.6 ± 1.0	4.5 ± 0.9
PD (site) (mm; mean ± SD)	1.1 ± 0.2	1.0 ± 0.2
Complete root coverage T_2 (n [%])	17 (22)	64 (43)
Rec reduction (T_0-T_2) (mm; mean ± SD)	1.8 ± 1.0	1.2 ± 0.8
KT gain (T_2-T_0) (mm; mean ± SD)	3.5 ± 1.0	3.4 ± 0.9
Rec reduction (T_1-T_2) (mm; mean ± SD)	0.8 ± 0.7	0.5 ± 0.6
KT gain (T_2-T_1) (mm; mean ± SD)	–0.8 ± 0.7	–0.7 ± 0.8

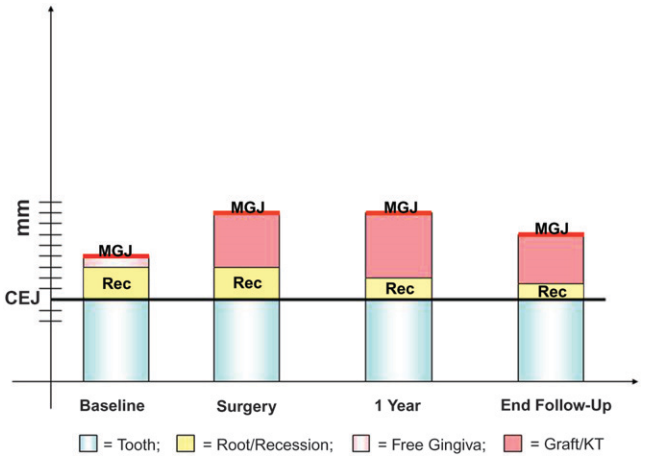

Figure 9.
Healing pattern of MFGG showing the coronal shifting of the gingival margin and the mucogingival junction (MGJ).

MFGG), baseline gingival recession, interproximal bone loss, and time of follow-up. In particular, subject age at the time of surgery was associated significantly with greater gingival recessions at T_1 and T_2 (P = 0.0124); SMFGG procedure, considering a baseline-adjusted recession depth with respect to cases treated with MFGG, showed a greater recession at T_1 and T_2 (P = 0.0016); overall, the greater the baseline recession, the greater the final recession (P <0.0001); in cases of baseline interproximal bone loss, the final recession was greater than the experimental sites that

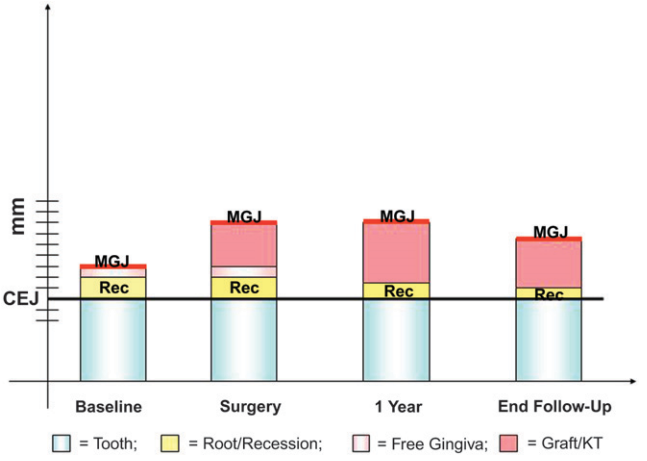

Figure 10.
Healing pattern of SMFGG showing the coronal shifting of the gingival margin and the mucogingival junction (MGJ).

Table 4.

Inferential Statistics Using Models at Three Levels (subject, tooth, and measurement [T_1 versus T_2]) With Outcome Variable of KT

Term	Estimate	SE	*P* Value
Intercept	5.58	0.35	<0.0001
Gender	0.40	0.21	0.0596
Smoking	0.11	0.23	0.6246
Age	–0.01	0.01	0.4367
Maxillary versus mandibular teeth	0.03	0.13	0.8357
Type of tooth*	–0.45	0.11	<0.0001
Surgery (SMFGG versus MFGG)	–0.19	0.13	0.1367
Interproximal bone loss	–0.08	0.16	0.6193
Restorations	0.20	0.13	0.1174
Splint	0.54	0.18	0.0026
Recession T_0	0.01	0.05	0.8703
Time (T_2 versus T_1)	–0.75	0.05	<0.0001
σ_v^2 (patient)	0.62	0.11	
σ_u^2 (tooth)	0.15	0.04	
σ_e^2 (measurement)	0.28	0.03	

σ_v^2 (patient) = patient variance; σ_u^2 (tooth) = tooth variance; σ_e^2 (measurement) = measurement variance.
* Premolars/molars versus incisors/canines.

Table 5.

Inferential Statistics Using Models at Three Levels (subject, tooth, and measurement [T_1 versus T_2]) With Outcome Variable of Gingival Recession

Term	Estimate	SE	*P* Value
Intercept	−1.05	0.24	<0.0001
Gender	0.01	0.13	0.9392
Smoking	−0.11	0.14	0.4398
Age	0.02	0.01	0.0124
Maxillary versus mandibular teeth	0.18	0.10	0.0772
Type of tooth*	0.12	0.09	0.1556
Surgery (SMFGG versus MFGG)	0.30	0.10	0.0016
Interproximal bone loss	0.24	0.11	0.0385
Restorations	−0.10	0.10	0.3274
Splint	0.12	0.12	0.3333
Recession T_0	0.70	0.04	<0.0001
Time (10 years versus 1 year)	−0.62	0.04	<0.0001
σ_v^2 (subject)	0.17	0.04	
σ_u^2 (tooth)	0.10	0.03	
σ_e^2 (measurement)	0.22	0.02	

σ_v^2 (subject) = subject variance; σ_u^2 (tooth) = tooth variance; σ_e^2 (measurement) = measurement variance.
* Premolars/molars versus incisors/canines.

did not show interproximal bone loss ($P = 0.0385$); and overall, Rec_{T2} was smaller than Rec_{T1} ($P < 0.0001$) (Table 5).

DISCUSSION

The main objective of this long-term (10 to 25 years) retrospective study was to evaluate the changes in the amount of KT and in the position of the gingival margin following application of free gingival grafts in sites presenting with complete lack of attached gingiva associated with gingival recession. Gingival augmentation procedures were performed by placing free gingival grafts at the marginal or submarginal gingival level. Root coverage was not the immediate and primary goal of these procedures.

The study showed that the gingival margin had shifted coronally 1 year after surgery, and additional shift was observed during the follow-up period. This modality of healing probably is attributable to the so-called "creeping attachment" that sometimes occurs after the positioning of free gingival grafts. This phenomenon is a "post-operative migration of the gingival margin tissue in a coronal direction over portions of a previously denuded root."[19] Some studies[21-24] reported that creeping attachment took place between 1 month and 1 year after surgery, whereas no other measurable coronal migration was observed after a longer period of time (5 years).[19]

On the contrary, the creeping attachment did not stop 1 year after surgery in the present study; continued coronal shift of the gingival margin (mean creeping 0.6 mm) was observed during the entire follow-up period (10 to 25 years).

Regarding the type of surgical procedure, MFGG led to a greater creeping attachment (0.8 mm) than SMFGG (0.5 mm). In some cases of baseline shallow recessions, the creeping attachment led to complete root coverage following both procedures (Tables 2 and 3). The complete root coverage observed in 17 cases treated with MFGG and in 64 cases treated with SMFGG might be explained by creeping attachment. In the sites treated with SMFGG, the baseline recession was shallower, on average, than at sites treated with MFGG. This could explain, at least in part, the greater amount of complete root coverage obtained in the group treated with SMFGG. The occurrence of true creeping attachment can be supported by the clinical observation that periodontal PD remained unchanged in all of the treated subjects through the entire observation period.

Another relevant conclusion may be drawn from the results of this study. Augmentation procedures were effective in halting the progression of recession over a long period of time (10 to 25 years); only two recessions increased slightly. Results comparable to those noted in the MFGG group were reported by Kennedy et al.,[17] who treated a group of 14 subjects with a combination of recession (2.3 ± 0.22 mm) and reduced attached gingiva (0.8 ± 0.19 mm) at baseline. After 6 years, the mean recession was reduced significantly (1.7 ± 0.30 mm) and KT increased (5.5 ± 0.14 mm). No data are available for SMFGG for historical comparison.

Regarding the amount of KT, a slight reduction (0.7 mm) was observed between 1 year after surgery and the end of the follow-up period, whereas the gingival margin shifted coronally (0.6 mm). These controversial remodeling patterns could be explained, at least in part, by a parallel coronal shifting of the mucogingival junction (1.3 mm). The potential tendency of the mucogingival junction to regain its original position after the gingival augmentation procedure may be supported by a similar trend reported following apical displaced flap[25] and coronally advanced flap procedures.[26]

Finally, in 48 of 224 teeth splinted by means of prosthetic restorations or bonded metallic ligatures before the gingival augmentation, a lower tendency

for KT reduction between T_1 and T_2 was observed with respect to non-splinted teeth. The reason for this difference could not be explained.

CONCLUSION

Gingival augmentation procedures (MFGG and SMFGG) performed in sites with an absence of attached gingiva associated with recessions provide an increased amount of KT and recession reduction over a long period of time (10 to 25 years).

ACKNOWLEDGMENT

The authors report no conflicts of interest related to this study.

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Correspondence: Dr. Giovanpaolo Pini Prato, Viale Matteotti, 11, 50121 Florence, Italy. Fax: 39-055-572881; e-mail: gpinipr@tin.it.

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